# Timing in CCQE Reconstruction

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**Schellman Group Meeting**

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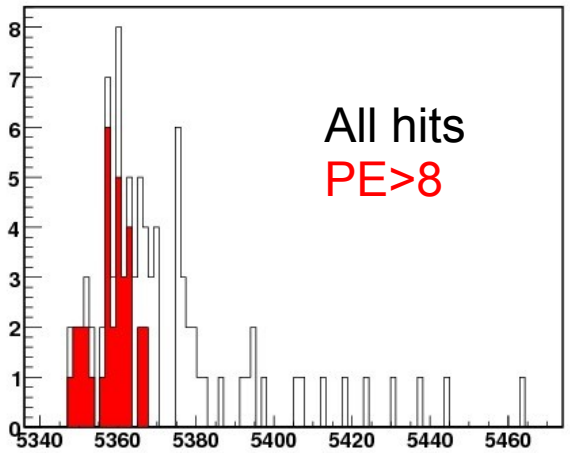
# CCEvent Timing

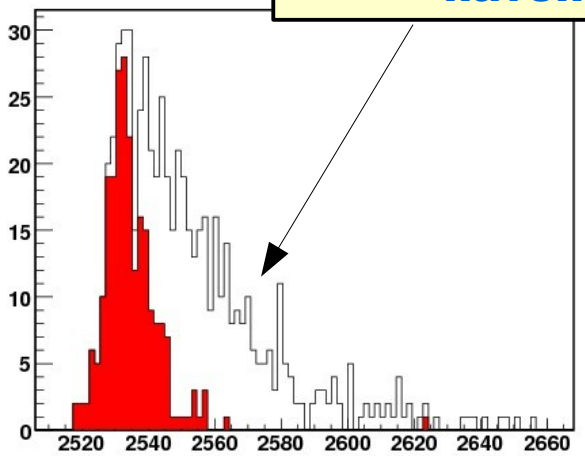
What do time distributions of MINERvA time slices that pass our CC Event Filter look like?

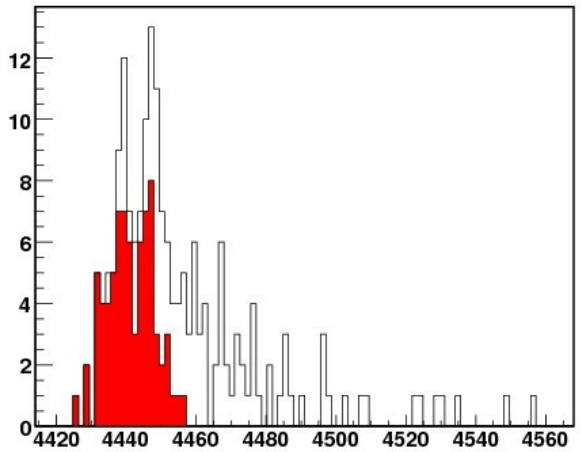
# CCEvent Timing

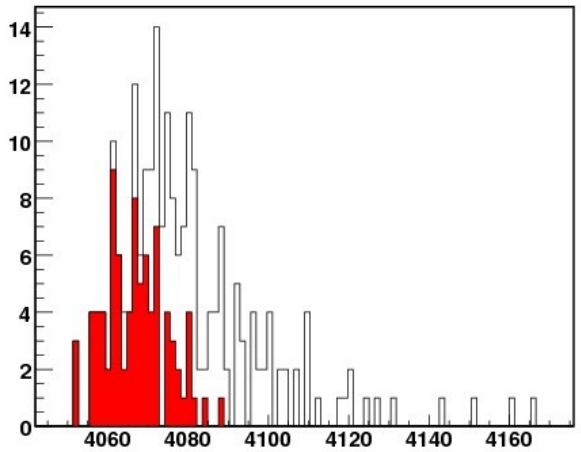
- Quite a few look like this (x-axes in ns):

**Low energy hits take a longer time to readout. We can (partially) correct for this, but haven't yet**



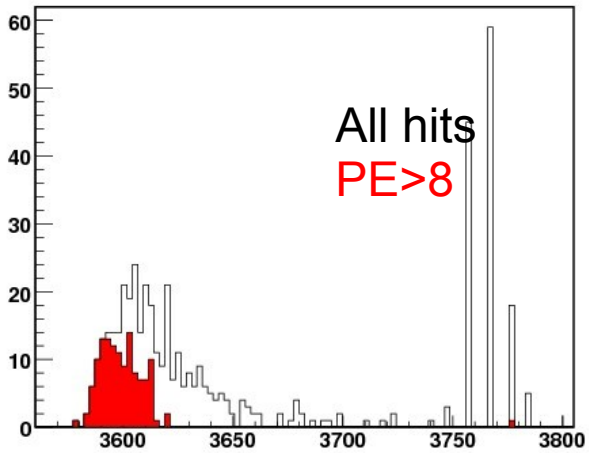



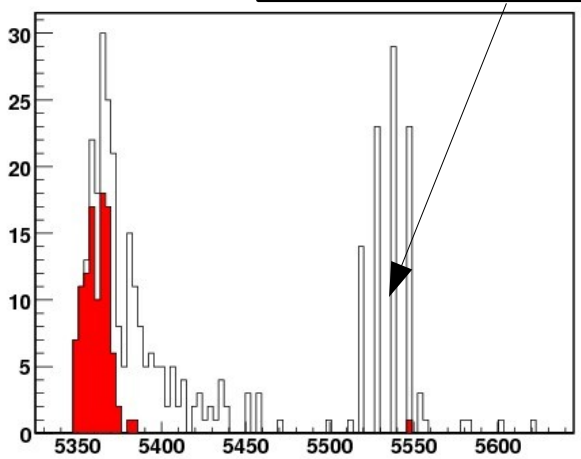



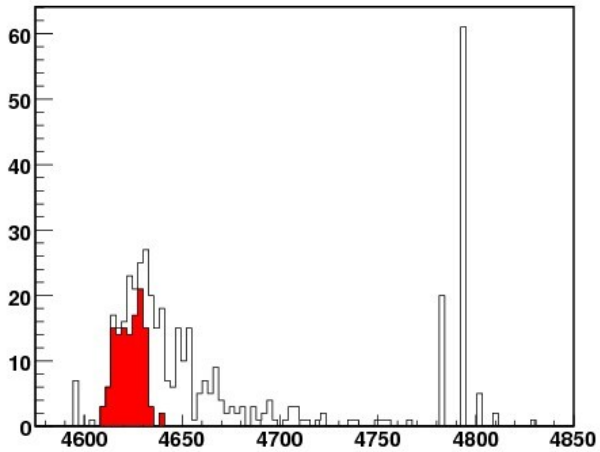
# Extra Energy Timing

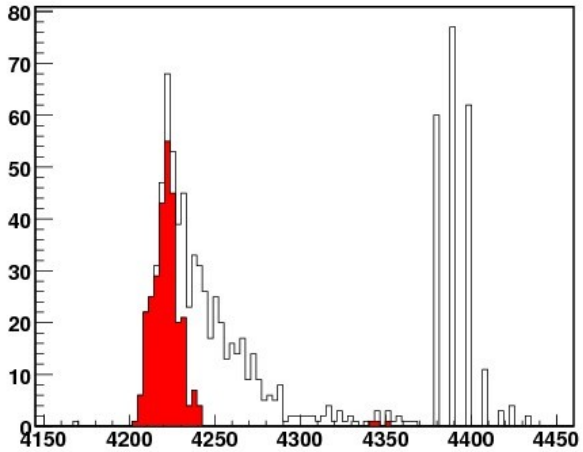
- More often, they look like this:

**Very low energy hits where discriminator didn't fire (these don't have proper timing information)**



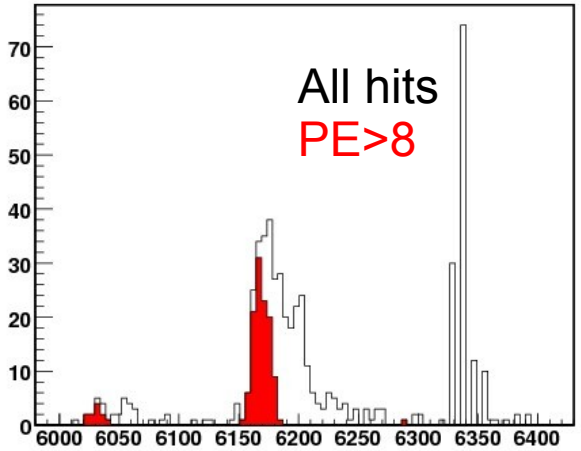



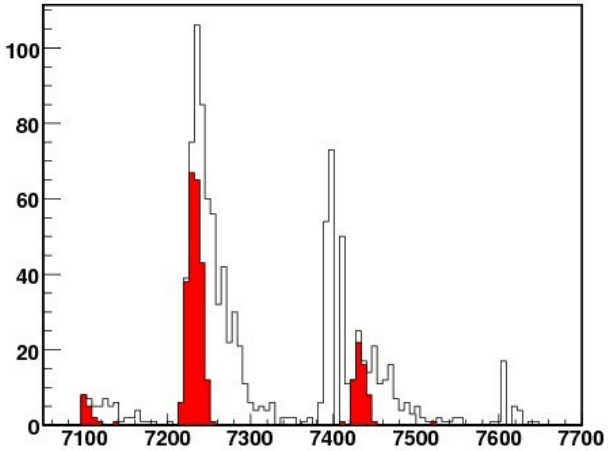



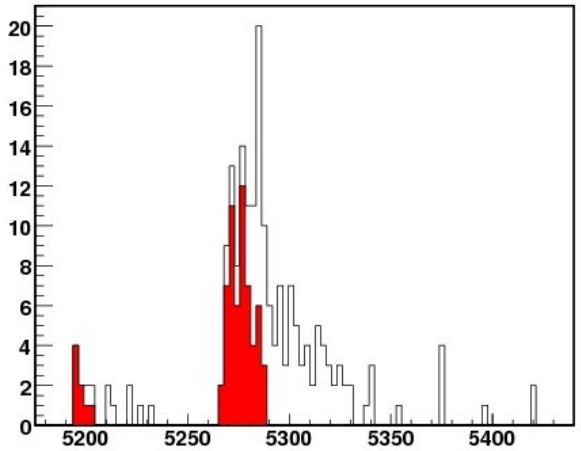



# Extra Energy Timing

- And a few look like this:



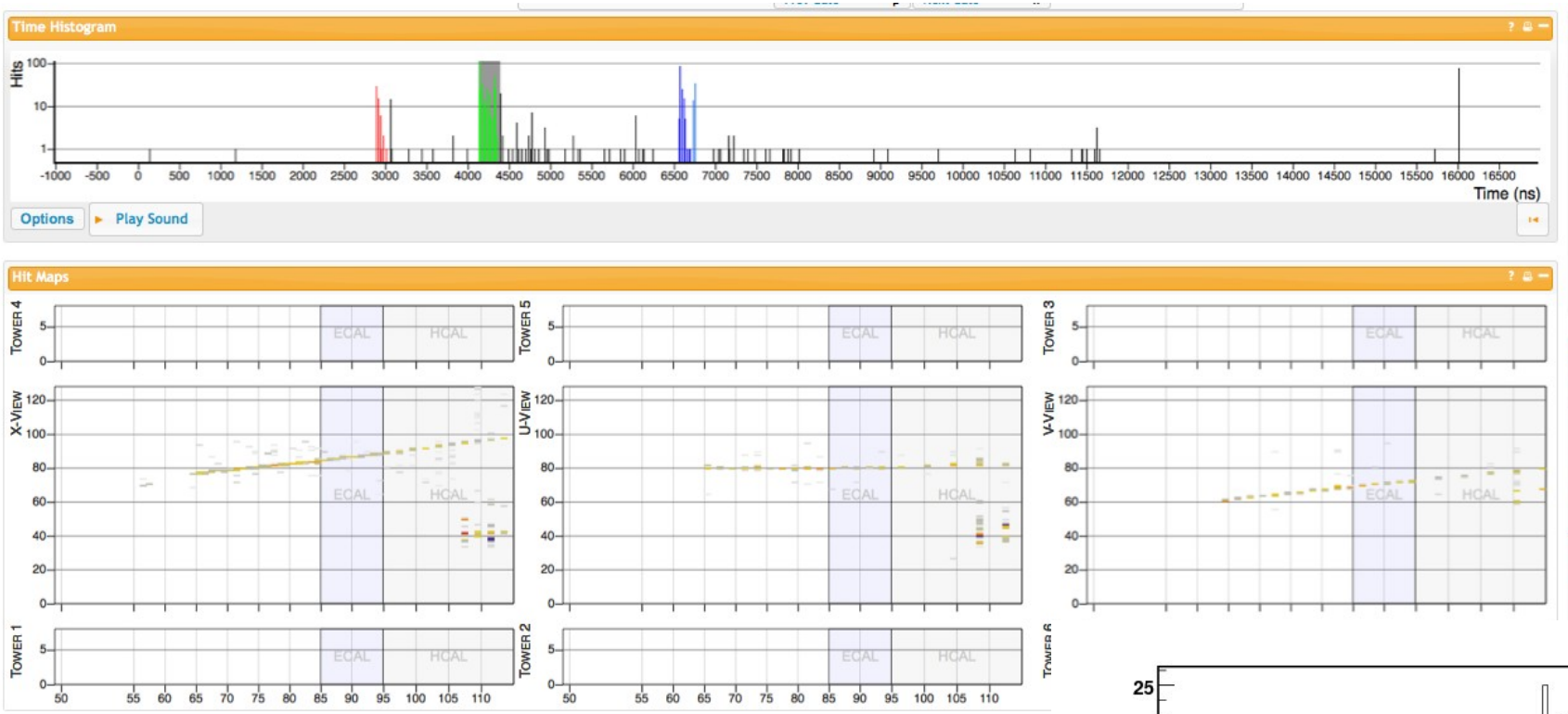

**These should have been separated into different slices by the chronobuncher, but weren't. Can we separate them after the fact?**

# CCEvent Timing

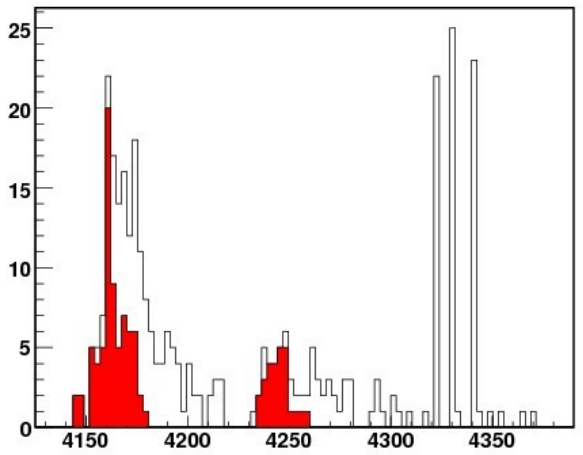
What do time slices with overlapping events look like?

The following slides contain event displays of events where CC muon time and extra energy time are far apart in time (> 30 ns)

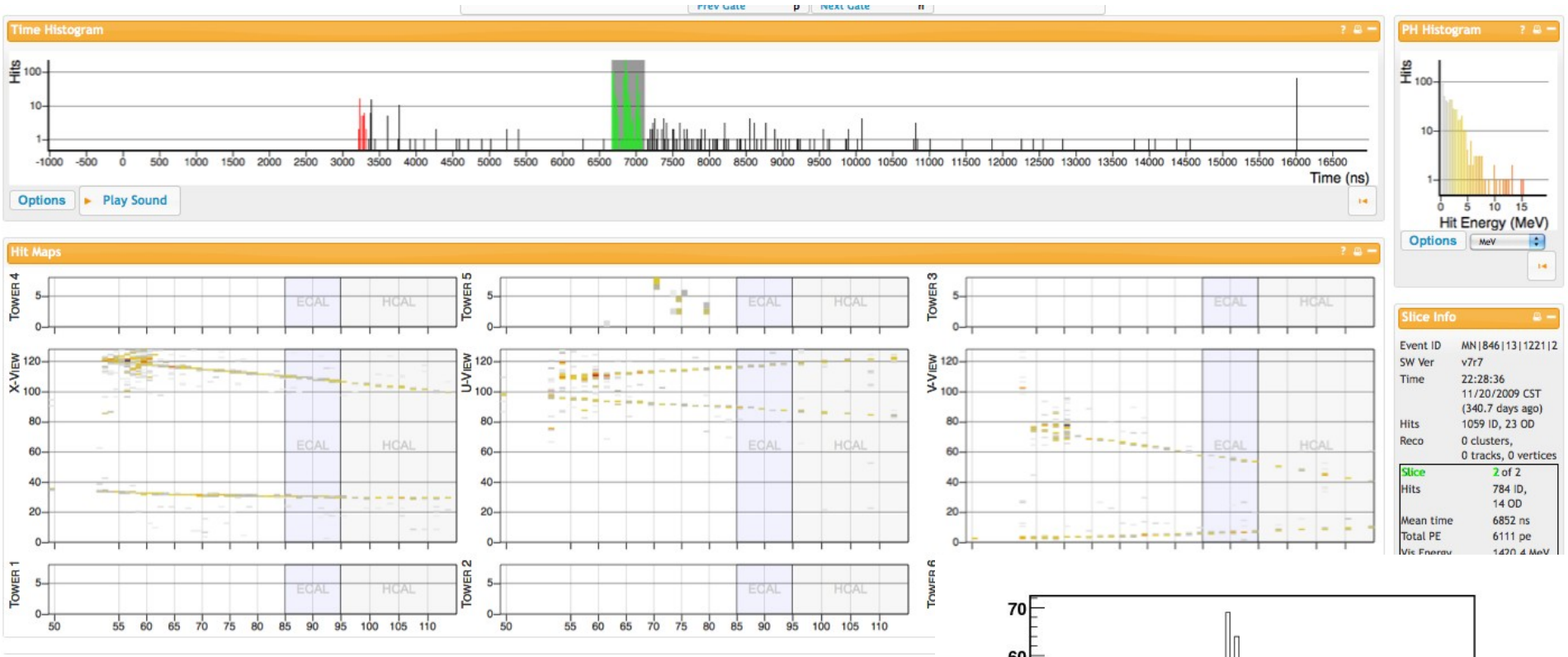
# CCEvent Timing

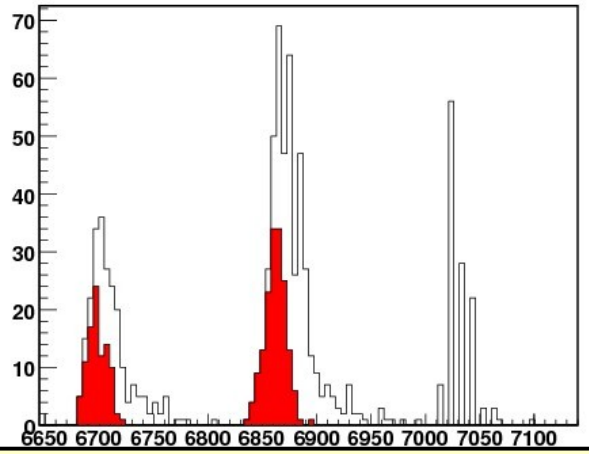



**Run 846/12 Gate 202 Slice 2**
**Extra Energy = 200 MeV**
**Track Time = 4150 ns**



# CCEvent Timing

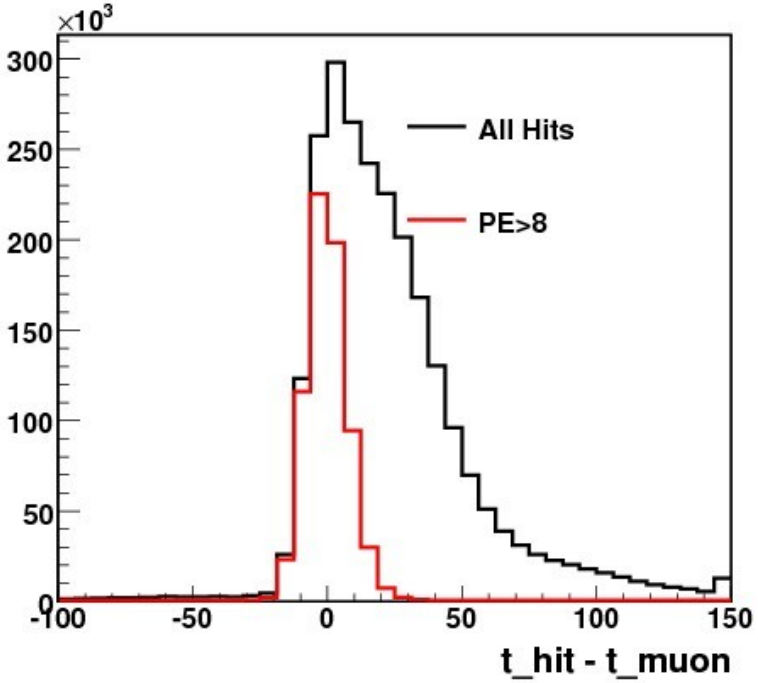


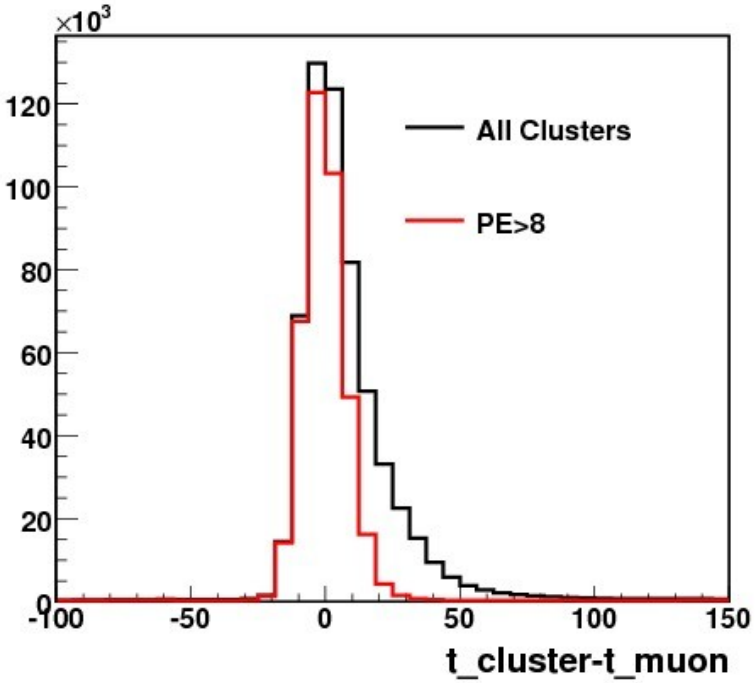
**Run 846/13 Gate 1221 Slice 2**
**Extra Energy = 816 MeV**
**Track Time = 6860 ns**

**Looking at timing distributions of events like these, it looks like a window of (-25, 75 ns) around the muon track would capture most of the rest of the "real" interaction**

# Extra Energy Timing




**Time of each non-track hit/cluster in time slice minus average time of muon track**




**A time window of (-25,+75) ns looks reasonable from these distributions too.**

# CCEvent Timing

- Where to go from here
  - Calculate extra event energy within time window.
    - How much do extra energy distributions change from those counted over the entire time slice?
    - Does data/MC agreement improve
      - Particularly in HE runs, where overlapping events are a big problem
  - Even with a smaller time window, there will be some overlapping events, and we need an estimate of how likely this is to occur:
    - How much efficiency do we lose by cutting events with large amounts of extra energy from overlaps?
    - How much do overlaps skew the recoil energy estimate in events that pass our extra energy cuts.